

TABLE OF CONTENTS

Chassis Dynamics

Subject	Page
Objectives of the Module	2
Electric Power Steering	7
Purpose of the System.....	7
System Components.....	8
Inputs and Outputs.....	11
Principle of Operation.....	12
Workshop Hints.....	14

Chassis Dynamics

Model: E85

Production Date: Start of Production MY 2003

Objectives of the Module

After completing this module, you will be able to:

- Describe how the “Sport” button affects the EPS system.
- Understand what must be performed on the EPS column for removal/installation.

Electric Power Steering (EPS)

Purpose of the System

With a conventional power assisted (hydraulic) steering system, a belt driven pump provides pressure to the control valve which is integral in the power steering rack. When the steering shaft is turned, the control valve provides pressure to assist (decrease effort) in turning the steering gear.

On some BMW vehicles, this control pressure is reduced by increasing vehicle speed via an electronically controlled bleed off valve (Servotronic). However; hydraulic power assisted steering systems utilize a reservoir, hydraulic fluid, pump, hoses/lines, cooler, hydraulic valve/steering rack, Servotronic valve, purpose built steering shaft and column.

Electric Power Steering (EPS) is used for the first time by BMW in the E85. It provides the typical BMW power assisted steering characteristics and “feel”. The EPS is a very direct, sporty steering element with a change-over between normal and “Sport” mode by the Dynamic Driving Control (Sport) button.

The EPS differs from the conventional hydraulic power assisted steering system by utilizing electrical/electronic components to provide power assisted steering *while retaining a complete mechanical connection*. The EPS is a "dry system", the hydraulic components and oil are not required.

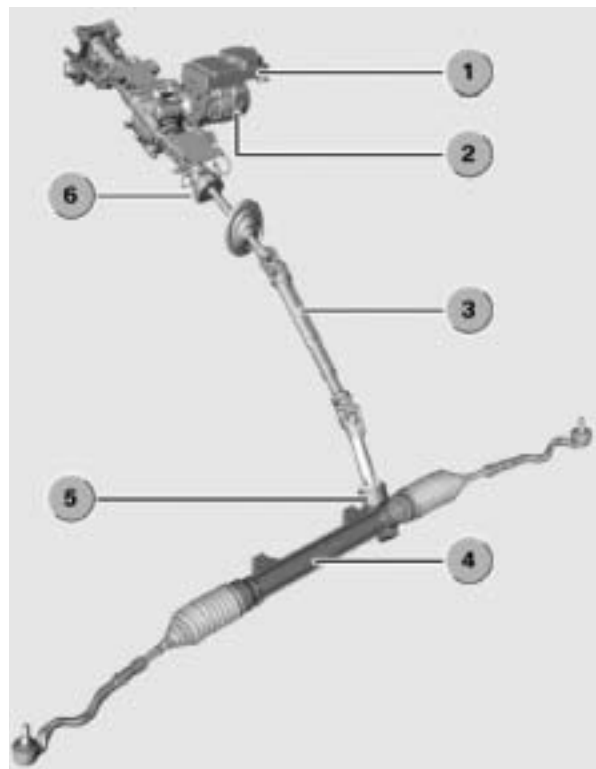
The programmed EPS control functions are influenced by vehicle speed and provide additional benefits regarding steering tuning, absorption adjustments and active steering return characteristics.

The EPS system includes:

- | | |
|--------------------------|--------------------------|
| 1. EPS Control Module | 4. Steering Rack |
| 2. EPS Electric Motor | 5. Steering Gears |
| 3. Lower Steering Column | 6. Steering Angle Sensor |

The advantages of EPS are:

- Less maintenance and assembly
- Improved driving dynamics
- Increased comfort
- Increased driving safety
- Weight reduction
- Increased environmental compatibility
- Less power consumption



Improved Driving Dynamics:

- The EPS Electric Motor provides good power assisted steering control characteristics.
- Active return to center.
- Switchable steering characteristic (Dynamic Driving Control).
- Use of light weight sport steering wheels (1kg less than other steering wheels).

Increased Driving Comfort:

- Decouples unnecessary steering oscillations (from road disturbances) while maintaining relevant road feel information (different road conditions) to the driver.
- Speed dependent steering assist force (parking vs. high speed driving).

Increased Driving Safety:

- EPS provides a direct mechanical connection to the steering gear, conveying direct road feel.
- Speed dependent steering actively absorbs left/right roll.

Increased Environmental Compatibility:

- Reduced fuel and engine power consumption
- Leak free "dry system"

System Components

The EPS system is divided into 3 component groups:

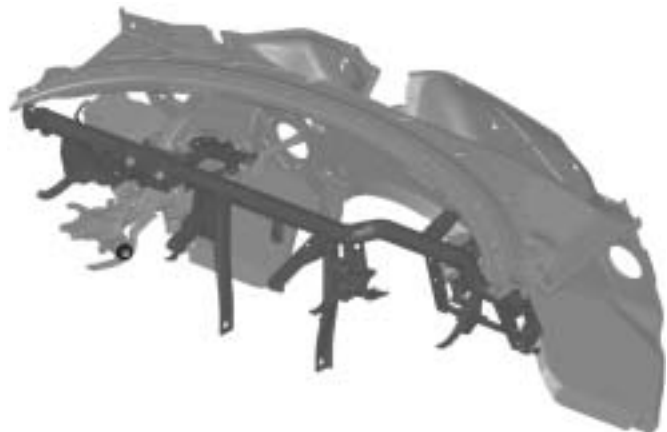
- Upper steering column assembly
- Lower steering spindle
- Steering gear with rack

Upper Steering Column Assembly

The upper steering column mechanical section starts at the steering wheel and ends at the connection to the lower steering spindle. The upper steering column is secured by 4 bolts to a bracket which is welded to the instrument panel support frame. In addition, the support frame bracket is secured by 4 bolts to the body.

The electrical section pertains to the EPS servo unit which consists of the EPS Control Module and the electric motor.

The remaining upper steering column section contains the steering lock with ignition switch and the steering column adjustment mechanism (manual tilt and telescopic).

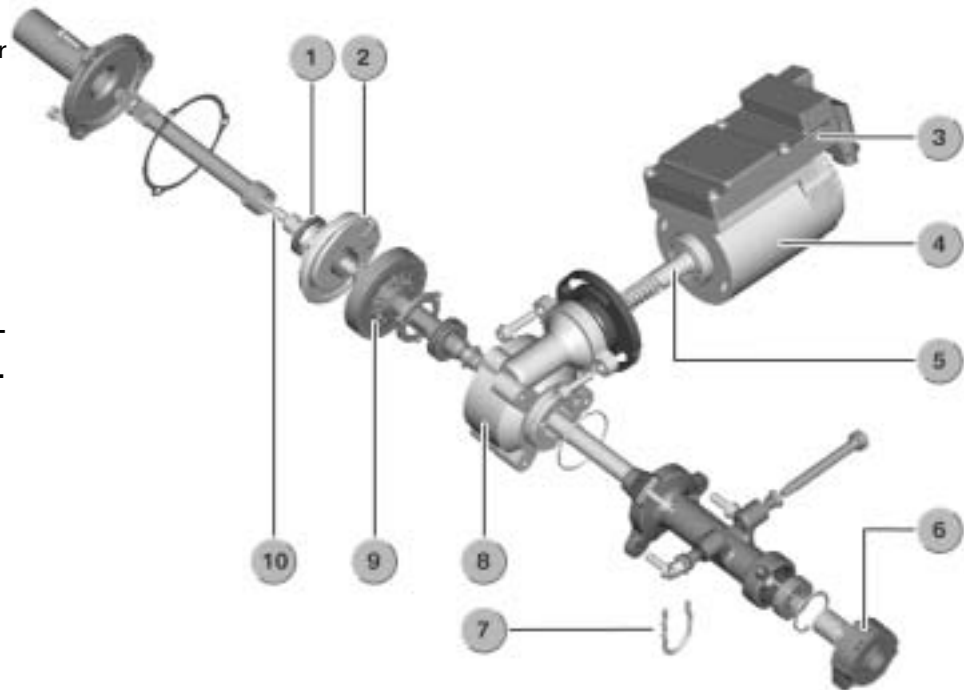


Servo Unit

The servo unit provides active steering-effort assistance as required by steering force and vehicle conditions. The servo unit is located on the upper steering column and is protected in the passenger compartment, it consists of:

- Electric motor
- Worm gear
- Control unit
- Internal sensors for electric motor speed, steering torque, temperature and voltage.
- Coil-spring cassette for the internal steering torque sensor.

1. Magnet wheel
2. Steering torque sensor
3. EPS control module
4. Electric motor
5. Worm gear shaft
6. Steering angle sensor
- 7. Shipping/service steering locking pin**
- Install before removing steering column.
- Remove after installing column.
8. EPS housing
9. Driven gear (meshes with worm gear)
10. Torsion bar



The electric motor and the worm gear in the servo unit produce a new acoustic pattern in the passenger compartment. The system acoustics can be heard in particular situations:

- When the steering wheel is spun quickly
- When the steering wheel is turned while the car is stationary
- When the steering wheel is turned in a quiet atmosphere (e.g. radio not turned on)

This acoustic pattern is not a system fault. The conventional sounds generated by hydraulic steering systems (pump modulation, limiting valve) are eliminated.

Note: The EPS Control Module cannot be replaced separately, the entire assembly with the exception of the Steering Angle Sensor must be replaced as a unit (VIN specific part #).

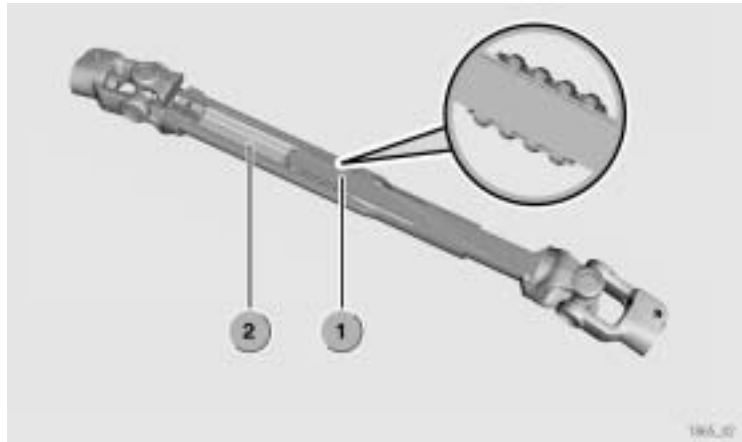
Lower Steering Spindle

The lower steering spindle connects the upper steering column to the steering gear. It runs in the engine compartment from the bulkhead through two universal joints to the steering gear. The lower steering spindle is encased in a plastic sleeve for corrosion protection. The sleeve is made from high temperature resistant plastic. The two parts of the lower steering spindle interslide in a ball-bearing mounting.

The ball-bearing mounting is necessary for:

- Self adjusting length
- Equalization during steering wheel height adjustment
- Telescopic collapsing in event of a crash

1. Ball bearing mounting
2. Telescopic compartment

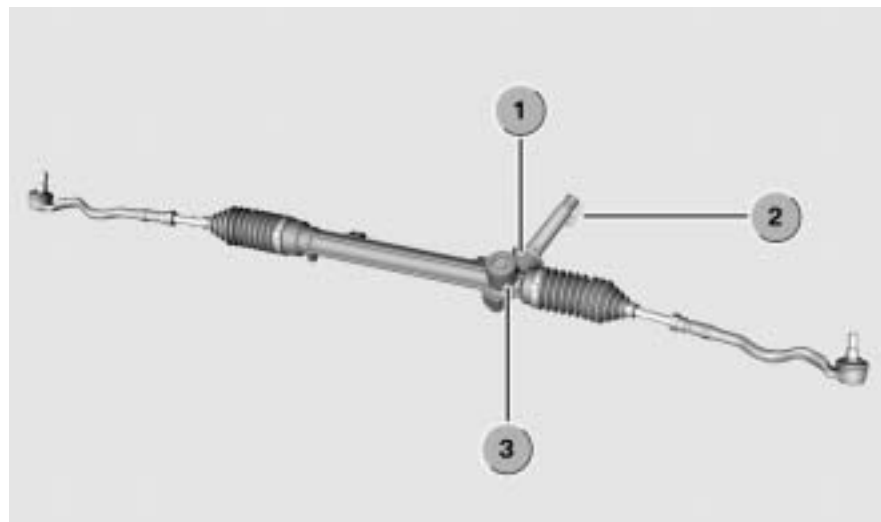


Steering Gear

The steering gear is a purely mechanical rack and pinion system. The steering deflection forces are counteracted by a damped thrust member, which is integrated in the steering gear.

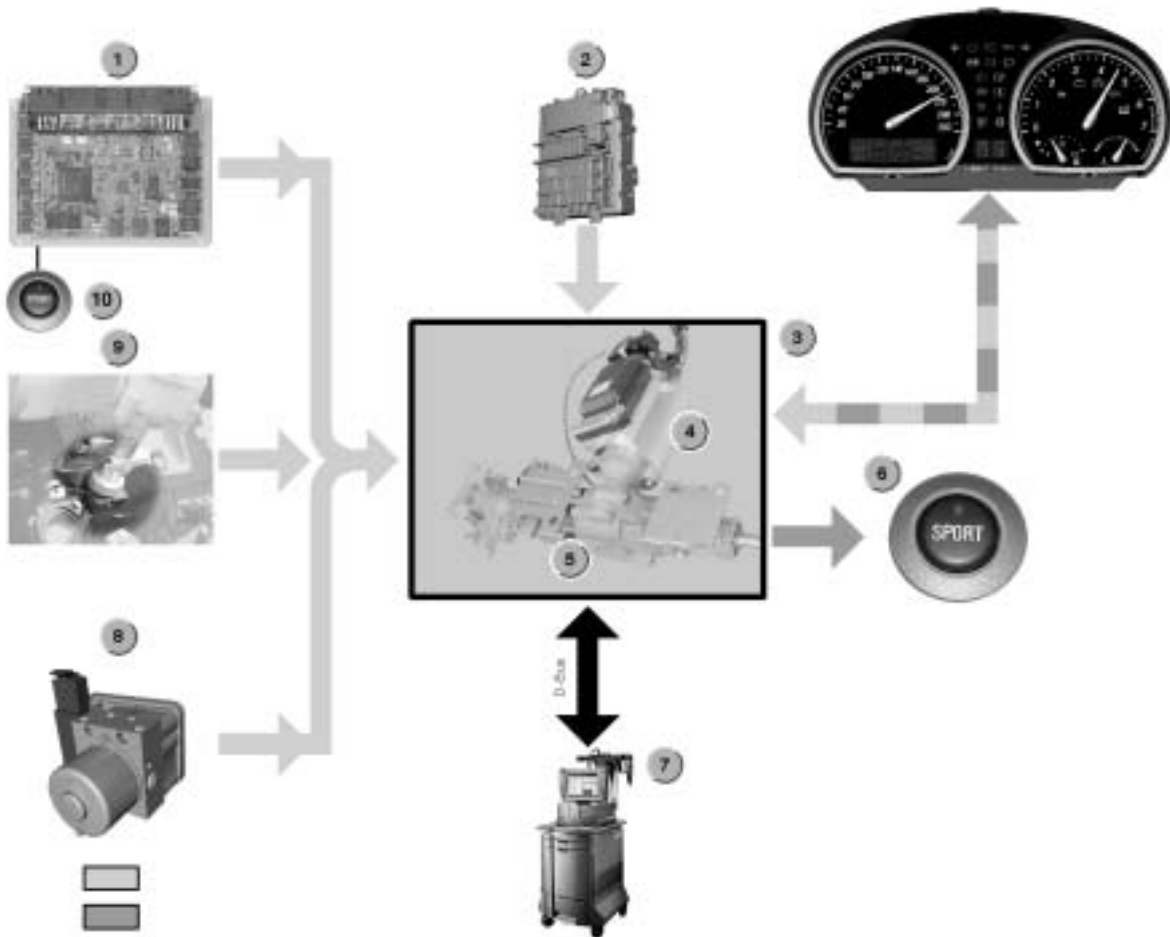
This thrust member has an integral damper element in addition to the tension spring. In the event of rapid steering movements, the rack is not influenced by high deflection forces. Without a damped thrust member, the rack would cause noises when returning at high speed.

1. Steering gear
2. Position lug
3. Thrust member



Note: The thrust member preload is not adjustable.

EPS - Input and Output Signals



1. MS45 ECM
2. Fusebox
3. Upper steering column with EPS servo unit and control module
4. Electric motor internal speed sensor
5. Internal steering torque sensor

6. Dynamic Driving Control "Sport" button illumination
7. DISplus
8. DSC control module
9. Steering angle sensor (LWS)
10. Dynamic Driving Control "Sport" button - function request via ECM

Notes:

Principle of Operation

EPS controls servo assistance for steering. In addition to the measuring the driver's steering torque, the EPS Control Module also monitors further inputs such as:

- Vehicle speed
- Steering angle velocity
- Steering angle
- Dynamic Driving Control (Sport) button
- Internal system temperature

The EPS calculates an assistance setpoint. The electric motor is activated via the integrated power electronics and the torque is transmitted through the worm gear to the driven gear (attached to the steering column output shaft).

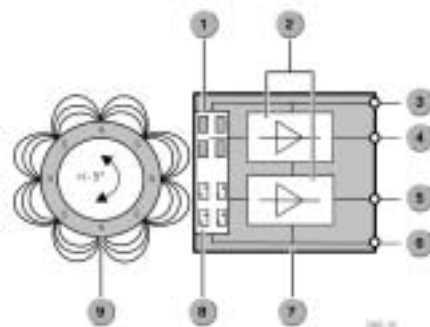
The Servotronic function (vehicle speed dependent steering assistance) is also integrated. The corresponding assistance and damping characteristics are stored in the EPS Control Module. The required assistance torque is gradually increased when the engine is started and reduced (with a delay) when the engine is switched off.

Steering Torque Measurement

The driver's steering torque is measured by a steering torque sensor integrated in the servo unit. The function is based on the magnetoresistive principle, these sensors are currently used in BMWs include wheel speed sensors (DSC III MK60) and Valvetronic position sensors (E65 - N62 engine). The magnetoresistive elements resistance changes as a function of the magnetic field acting on them.

The input shaft of the upper steering spindle is connected by a torsion bar to the output shaft. A magnet wheel is mounted on the input shaft. The magnetoresistive element is mounted on the output shaft.

The magnetic field lines are deflected by the magnet wheel as a result of the rotation of the input shaft with respect to the output shaft (slight twist due to the resistance from the tires on the road, steering gear, etc.). This deflection generates a resistance change (in one of the resistors) causing a voltage change in the evaluation electronics.



Two output signals (different voltage values) are generated which are constantly monitored for plausibility by the EPS Control Module. Based on this voltage change, the EPS calculates the extent of the driver's steering torque. The leads for signal transmission, power supply and ground run in a coil spring cassette mounted on the pinion shaft. The coil spring cassette is located in the worm gear housing.

Steering Angle Measurement

To be able to perform active steering wheel resetting (return to center), the EPS Control Module requires the following:

- Steering wheel center position
- Present steering wheel angle

The above information is input to the EPS Control Module by the steering angle sensor (LWS), in addition to the DSC system requirement. The steering angle sensor is located on the lower steering column in the passenger compartment.

Note: The steering angle sensor must be calibrated (like the E46 DSC).



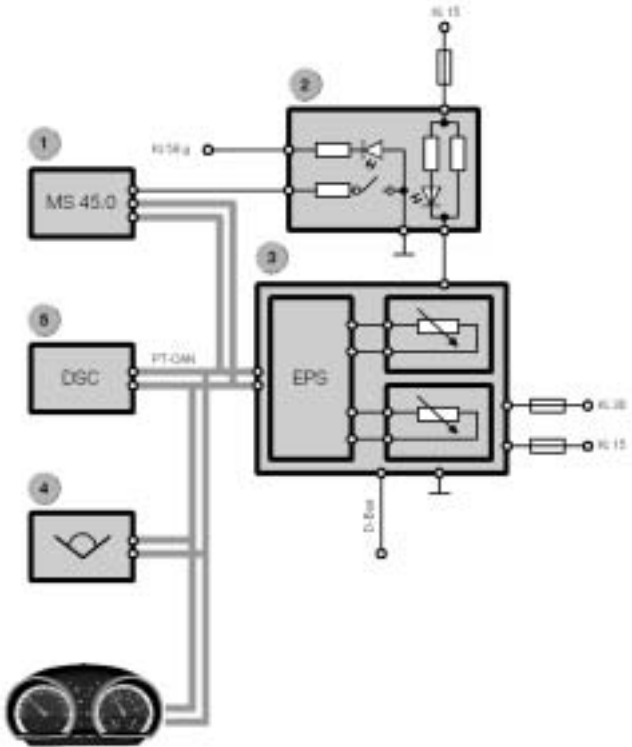
4. Steering angle sensor (LWS)

Dynamic Driving Control Function

When the Dynamic Driving Control function is selected with the “Sport” button, the engine management system directs the request signal via the PT-CAN Bus to the EPS Control Module.

The EPS Control Module switches to sporty vehicle handling. This provides higher steering and holding forces.

1. MS45 ECM
2. Dynamic Driving Control “Sport” button
3. EPS servo unit and control module
4. Steering angle sensor (LWS)
5. DSC control module



Indicator Light

The instrument cluster contains an indicator light for the EPS system. This light alerts the driver to significantly reduced steering effort assistance or to a complete shutdown of assistance. This may be caused by:

- Fault in the EPS Control Module or an associated control module (DSC, ECM).
- Undervoltage/overvoltage
- Overloading of EPS



Workshop Hints

Servo Assistance Reduction or Shutdown

When the EPS system is overloaded, it protects itself by reducing or shutting down servo assistance *while retaining a complete mechanical connection for steering*. The driver notices the increased steering torque and receives a visual signal from the indicator light.

The following causes will implement protective measures:

- Servo assistance is reduced/shut down if a fault relevant to EPS is detected in an associated Control Module/sensors (ECM, DSC Control Module, Steering Angle Sensor). A fault code is stored and the indicator light in the instrument cluster illuminates in the event of complete assistance shutdown.
- Power assisted steering is reduced as EPS internal temperature increases (due to overloading). When reduction of the power is not sufficient to cool the system down, servo assistance is reduced down to zero. A fault is stored and the indicator light in the instrument cluster illuminates. When the temperature cools down, servo assistance returns within 2 seconds to the present requested value.
- In the event of overvoltage ($> 17\text{ V}$), servo assistance shuts down immediately to protect the output transistors. A fault is stored and the indicator light in the instrument cluster illuminates. When the voltage drops ($< 16\text{ V}$), servo assistance returns within 2 seconds to the present requested value.

- If an undervoltage ($< 9\text{ V}$) is detected, servo assistance is immediately reduced down to 0. A fault is stored and the indicator light illuminates in the event of complete assistance shutdown. When the voltage returns to a level $> 10\text{ V}$, servo assistance increases within 2 seconds to the requested value. In all cases, the indicator light goes out when the fault is no longer present.

Default Structure

Default 1 - Complete shutdown (Control Module, under/over voltage, no assist).

Default 2 - When the steering is held in left/right lock position > 40 seconds, power is reduced by 50% (due to increasing internal temperature).

Default 3 - Vehicle speed signal is missing, Servotronic feature is deactivated.

Default 4 - When the Steering Angle Sensor (LWS) input is defective, active return centering is deactivated.

Working on Steering Column

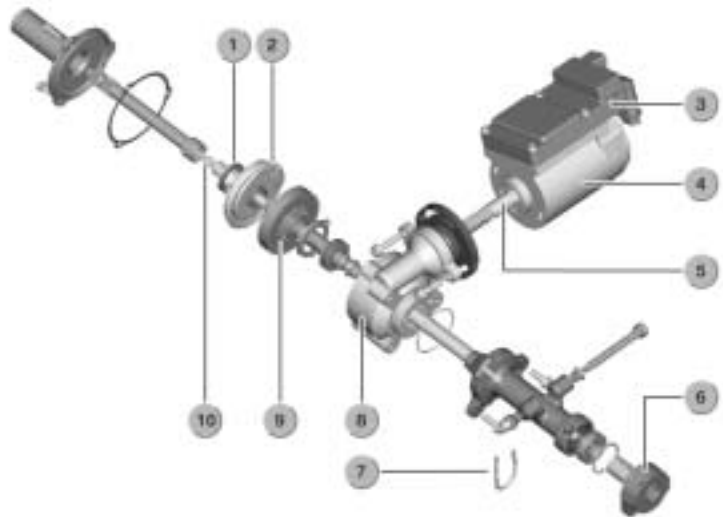
Before performing any work on the steering column, it is required that the steering locking pin is engaged in the "centering" position! This prevents turning of the steering spindle during installation.

7. Shipping/service steering locking pin

- Install before removing column.
- Remove after installing column.

If the steering spindle is turned, this will break the internal sensors' connecting harness to the EPS Control Module.

The connecting harness is located in the coil spring. The spring is installed in the servo unit housing.



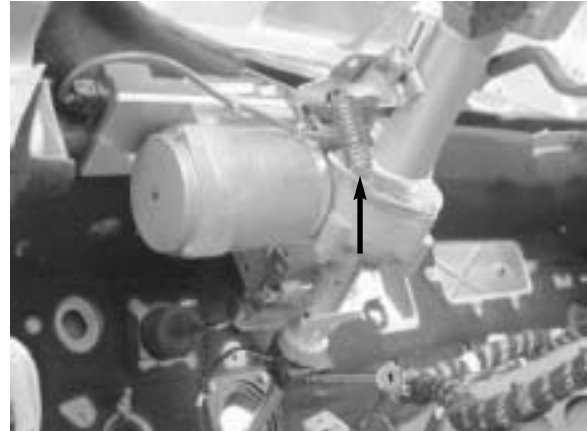
When the lower steering spindle is disconnected from the steering gear, it is important when reinstalling to ensure that the center marking on the lower steering spindle is aligned with the center marking on the steering gear. The upper steering spindle and the steering gear are equipped with plastic lugs which determine the correct installation position of the lower steering spindle.

General Information

The mass balance spring (arrow) should be disconnected when work is performed on the upper steering column.

Caution: The mass balance spring is under extreme tension. Be careful not to bend the spring tab mounting retainers.

Note: Only the ignition starter switch, the lock cylinder and the Steering Angle Sensor (LWS) can be replaced as separate components on the upper steering column.



Diagnosis

System faults and additional information pertaining to vehicle responses are stored in the EPS Control Module's fault memory and can be diagnosed with DISplus/GT1.

